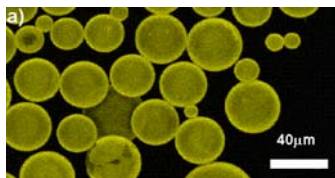


# RESEARCH CLUSTER N: Nanostructured Materials

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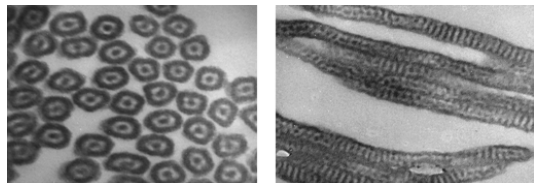
This research cluster focuses on the generation and fabrication of polymer-based nanostructured materials. Through molecular design, synthesis and characterization of block copolymers, hybrid polymers and functionalized nanoparticles, the self-assembly of polymers can be harnessed to produce nanostructured materials with hierarchical structure. By manipulating the chemical nature of the polymers, controlling interfacial interactions, or applying external fields, self-assembly processes are being directed so as to achieve specific structural and functional properties ranging from the mechanical to magnetic to optical.

Cluster N integrates expertise in the functionalization of nanoscopic particles to mediate the assembly of nanoscopic particles, thin films of multi-component systems and self-assembled block copolymers (BCP), fabrication and characterization of functional nanoscopic systems and hierarchical nanostructured polymers, precise control of block and graft copolymer molecular architectures, and the novel design of self-assembling hybrid materials to optimize morphological and mechanical properties.



Water droplets dispersed in oil that are encapsulated by a cross-linked monolayer of nanoparticles.

This cluster parallels several NSF funded programs. The Materials Research Science and Engineering Center (MRSEC) has two Interdisciplinary Research Group efforts that focus on fundamental scientific issues that underpin the fabrication and use of nanoscopic materials in the bulk and in thin films. UMass is also home to the Center for Hierarchical Manufacturing, a Nanotechnology Science and Engineering Center (NSEC).



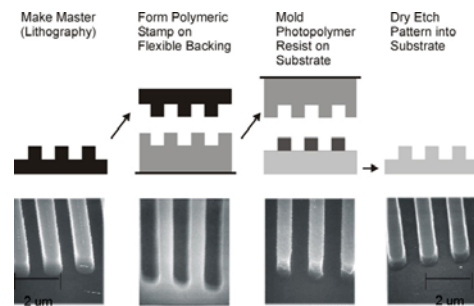
TEM Micrograph copolymers confined in alumina membranes

Current research activities and directions include:

- Directed self-assembly of multi component polymers
- Self-assembly for advanced lithography
- Polymer mediated assembly processes
- Synthesis of functional polymers to tailor nanostructures
- Synthesis of organic/inorganic hybrids
- Electrochemical deposition for nanofabrication
- Nanoparticles for device, catalytic, bio recognition and encapsulation applications
- Design and manipulation of
  - photonic band gap materials
  - magnetic storage arrays
  - ultra thin field emission devices
  - nanoelectrode arrays
  - sensor and biosensor devices

Cluster N has an expanded program in *Nanoimprint lithography* (NIL) with a goal to develop new materials and processes that enable the fabrication of new and useful nanostructures with a focus in three major areas: imprint templates, imprint resins and pattern transfer.

Researchers in Cluster N have assembled a suite of state-of-the-art nanoimprint equipment and supporting process tools housed in a new Class 1000 cleanroom. The facility was made possible by funding from the two NSF Centers (MRSEC and NSEC) and the Commonwealth of Massachusetts. The Nanoimprint Lithography lab not only provides an efficient, economical means for combining the novel materials approaches developed at UMass with real-world device fabrication, but also establishes a forum upon which UMass researchers can play a leading role in bringing nanoimprint lithography techniques to full-scale implementation in industry. A short list of the tools contained in the laboratory includes a Molecular Imprints MI-55 Step and Flash Imprinter, a Nanonex NX-2000 Imprinter, a Trion ICP plasma etcher, a Süss MA-6 mask aligner and other tools, that make one-of-a-kind nanoimprint research facility.



New robust and economically viable nanoimprint templates are needed. One avenue of active research is the exploration of alternative templates such as polymer based molds or the surface of patterned BCP assemblies to replace expensive quartz devices. Cluster research involves the development of novel approaches to establish structure-property relationships of the nanostructured elements as a guide in the materials selection and geometry designs used in NIL. *In situ* contact adhesion tests are performed in order to quantify the mechanical stresses that develop during the NIL processes and the template's separation. This information is critical in the development of NIL and its extension to advanced materials, such as BCPs.

In recent research, the imprinting of functional polymer layers has been accomplished allowing for the direct patterning of active polymer device layers. Patterned organic electrics and low k materials has been demonstrated. New device architectures are also being explored. For example, the ability to clone devices – essentially use imprint techniques to copy existing devices in a rapid and inexpensive processes allows for the rapid prototyping of devices.

## Contact Information

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